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Prescribed Burning to Increase Mortality of Pandora Moth Pupae

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Prescribed burning of three different locations did not consistently cause satisfactory mortality to pandora moth pupae. It should be used only when the burning simultaneously achieves other objectives. Litter depth and distribution are important in uniformly heating and burning the proposed area.

Keywords: Pandora moth, *Coloradia pandora*, prescribed burning, fire effects

Few studies have investigated the use of fire to increase mortality of forest insects (Komarek 1970). Most economically damaging insects in western forests live on or in the tree where they would not be susceptible to fire unless the forests were severely burned. The pandora moth, *Coloradia pandora* Blake (Lepidoptera: Saturniidae), is an exception, because the larvae pupate in the soil and remain there from July of one year until the following July. Thus, they are susceptible to spring and fall prescribed burning under certain stand conditions. Prescribed burning has not been used to control the pandora moth, although Furniss and Carolin (1977) reported the Mono Indians used fire to cause the larvae to drop to the ground. This may have been an erroneous interpretation of Patterson (1929), who indicated the Indians used fire to dry larvae for food but not to increase their mortality.

This study was conducted to determine the effect of early summer prescribed burns on pupal survival, in stands of mature ponderosa pine, *Pinus ponderosa* Douglas ex Lawson.

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Study Area

In 1979, a pandora moth infestation was detected on the Kaibab National Forest, near Jacob Lake, Arizona. Larval densities were high enough to cause nearly complete defoliation of mature ponderosa pine in some parts of the infested area. The larvae pupated in the litter and soil, in June and July 1979. Pupal densities exceeded 10 per square foot in preliminary samples taken from around the bases of trees.

Three potential, prescribed burning locations (A, B, C) were selected in early June 1980 (fig. 1). Physical characteristics of each are listed in table A-1. Basal areas for the three locations ranged from 125 to 150 square feet in 1973; the basal area was concentrated in large (16- to 19-inch) and oversize (≧20-inch) sawtimber. Harvesting of the overmature, poor risk and form trees was begun in 1975 and completed in 1979. Locations A, B, and C were thinned to basal areas of 80-100, 100-110, and 80 square feet. All three locations were understocked with seedlings and saplings. They were chosen essentially without seedlings and saplings to reduce the possibility of a conflagration. Litter depth varied; it was greatest around tree bases and thinnest in openings between tree crowns. Although the litter was sparse in spots, litter conditions were thought to be representative of mature ponderosa pine stands on the north rim of the Kaibab plateau.

Methods

On June 24-25, 1980, the three locations were sampled to determine the pre-burn pupal densities. To disperse sampling throughout locations, four parallel compass lines were run across each location, and square foot plots were established at prescribed distances along each line. The distance between adjacent compass lines and plots along each line varied, depending on the size of the area. As each plot was established, another square foot plot was taken at the base of the closest tree 5 inches or more in diameter. Samples were taken near the tree bases, because pupae were thought to be concentrated there. Thus, plots on compass lines, unless they happened to fall near the base of a tree, would not reflect these concentrations. A total of 38, 28, and 24 line and tree plots were taken in locations A, B, and C, respectively.

The pupae in each plot were removed from the litter and first few inches of soil and were placed in petri dishes. Each dish was labelled as to area, transect line, and plot number. The dishes were transported to the laboratory in Fort Collins, where they were kept at room temperature. Adults eventually emerged, were counted, and the numbers were compared to postburn counts.

During the night of June 25, 1980, location C was burned with a backing fire (see table A-1 for fuel conditions). A backing fire burns against the wind and, thus, spreads more slowly than a fire burning with the wind. Because the fire danger was extreme at that time, burning of locations A and B was postponed. In the evening of July 14, 1980, locations A and B were burned with backing fires.

The morning after each fire, pupae were collected from plots along transect lines and the tree bases, according to the design used for the preburn samples, except that transect lines were offset 33 feet from the original lines to prevent sampling from the same location. Pupae from the post-treatment samples were placed in petri dishes, transported to the laboratory in Fort Collins, where they also were kept at room temperatures. Adults emerged in the dishes. In late August 1980, pupae from which adults had not emerged were dissected to determine if significant numbers of pupae had matured but failed to emerge.

Figure 1.—Stand conditions on location A.

Mean numbers of adults emerging from the preburn and postburn samples for each location were compared.

Results and Discussion

The mean density of emerging adults changed at all three locations (table 1). Locations A and B showed decreasing numbers of emerging adults between the preburn and postburn samples. Survival of pupae at tree bases decreased more than along transects. Location C showed an increase in the postburn densities of emerging adults along transect lines but a decrease in the densities at tree bases. These results reflect extremely variable pupal densities and the effects of the fire. While mean pupal densities averaged about 3 pupae per square foot in preburn and postburn samples, densities per square foot ranged from 0 to 32 pupae. This wide range suggests additional sampling may have increased the precision of the estimated densities and more clearly defined the effects of the burning. In addition, many pupae in both samples failed to develop and/or emerge, indicating inadequate rearing techniques or pupal mortality unrelated to the burning. However, despite these deficiencies, the percent changes (table 1) still reflect the efficiency of the prescribed burning under the existing stand conditions.

The fires generally caused higher mortality in areas with substantial depths of litter, such as the area within 3 to 6 feet of the base of a tree. Near and outside the dripline of the tree crowns, where the litter depth was less than 1 inch or nonexistent, the burning caused little or no pupal mortality. Because pupal densities 10 feet from the base of the tree were not different from those immediately adjacent to the base[4] and are probably just as high outside the dripline of the crown (contrary to prior belief), the negligible pupal mortality in these unburned and lightly burned areas decreased overall mortality and the efficiency of the burning. Thus, the overall mortality for each location attributable to the prescribed burning is somewhere between mortality near the tree bases and mortality in areas with sparse litter depth.

The pandora moth population in the three areas probably was not reduced enough by the prescribed burning to limit the 1981 defoliation to the light category. Using the presented data, subsequent abundance of adults can be approximated and defoliation estimated. Assuming the density of the pupae was 3 per square foot, then about 130,000 were present on each acre. If 50% of the pupae produced moths, 62,500 moths would fly. However, if a prescribed burn killed 60% of the viable pupae (the average of the negative percent changes in table 1), only 25,000 adults would emerge. More than half of the emerging moths would be females;[4] therefore, the larvae hatching from the egg masses of the 13,000+ females would be able to cause at least moderate defoliation.

[4] *Schmid, J. M., Unpublished data on file at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.*

Conclusions

Prescribed burning of stands where litter depth is interrupted and sparse in substantial portions of the area will not yield the moth population reductions normally desired from a control technique. If substantial litter is uniformly distributed throughout the stand and burning conditions are satisfactory, then prescribed burning becomes a more valuable control technique. If other objectives, such as fuel reduction or wildlife habitat management, can be achieved with the same fire used for pandora moth reduction, then the value of the prescribed burning is enhanced, even though it may not attain the desired pupal mortality.

The use of fire should not be completely dismissed because these results are not completely acceptable. Fall burning to increase pupal mortality, spring burning to effect larval mortality when the larvae are feeding, and spring burning when the larvae are leaving the trees to pupate are alternatives which should be tested. Larval and pupal population levels also should be measured periodically in the recently burned areas to determine if the fire decreases survival of later generations.

Literature Cited

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Table 1.—Mean number of collected pupae and percent of emerging adults from preburn and postburn samples, on transect lines and near the bases of trees

Location	Collected pupae				Emerging adults		% change caused by treatment
	Preburn		Postburn		Preburn	Postburn	
	$\overline{X}$	*SD*	$\overline{X}$	*SD*	%	%	
Transects							
A	2.8	4.2	3.3	4.2	52	40	− 23
B	3.7	4.2	2.7	6.5	55	22	− 60
C	3.6	3.2	5.9	9.4	38	54	+ 142
Tree Bases							
A	3.4	4.8	2.7	4.1	50	27	− 46
B	3.8	4.5	1.3	1.5	37	0	− 100
C	3.2	3.2	1.2	1.6	58	20	− 66

Table A-1.—Summary of physical, meteorological, and fuel conditions for the three burn locations

Condition	Location		
	A	B	C
Hours burned	2050-0230	1900-2245	2130-0100
Temperatures (° F)	54-62	54-68	49-57
Relative humidity (percent)	18-29	22-35	27-34
Wind speed/direction	1-7, S-W	1-4, S/SW	Calm-2, S/SE
Slope (percent)	0-30	5	0-5
Aspect	West	North	Ridgetop
Elevation (feet)	7,800	7,800	8,000
Acreage	2	0.5	0.75
Fuels	Ponderosa pine duff, needles and light slash		
Loading (tons/acre)	5	4	4
Available (tons/acre)	4	3	2-3
Last precipitation (days since)	6 (0.05)	6 (0.05)	30 +
Fuel sticks (10-hour)	4	4	3-4

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